TARGETED SAMPLING OF FISH SPECIES AT RISK IN THE GRAND RIVER WATERSHED, 2003

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by

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ABSTRACT

Mandrak, N.E., J. Barnucz, and D. Marson. 2010. Targeted sampling of fish species at risk in the Grand River watershed, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2922: v + 29 p.

In 2003, Fisheries and Oceans Canada (DFO) conducted targeted sampling of fish species at risk (SAR) in the Grand River watershed. Targeted sampling refers to the non-random sampling of habitats thought to contain "target species" based on previous sampling, using gears most likely to capture "target species". Targeted sampling for the Redside Dace (*Clinostomus elongatus*) focused on areas of historical presence in the Irvine River, a tributary of the Grand River. Sampling for the Eastern Sand Darter (*Ammocrypta pellucida*) occurred in the Grand River proper, between the cities of Brantford and Caledonia, Ontario. Sampling techniques for targeted sampling included backpack electrofishing, boat seining, bag seining and straight seining. Three fish SAR were captured, including the Black Redhorse (*Moxostoma duquesnei*), Redside Dace and Silver Shiner (*Notropis photogenis*). Targeted sampling was not successful in locating eastern sand darter from sites where they were historically known. Further sampling is recommended in order to update the status of eastern sand darter in the Grand River watershed, as well as to monitor fish SAR.

RÉSUMÉ

Mandrak, N.E., J. Barnucz, and D. Marson. 2010. Targeted sampling of fish species at risk in the Grand River watershed, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2922: v + 29 p.

En 2003, Pêches et Océans Canada (MPO) a procédé à l'échantillonnage ciblé d'espèces de poisson en péril (EP) dans le bassin versant de la rivière Grand. L'échantillonnage ciblé consiste à effectuer un échantillonnage non aléatoire d'habitats où l'on soupçonne la présence d'« espèces ciblées », d'après des échantillonnages antérieurs, à l'aide des engins les plus susceptibles de capturer les « espèces ciblées ». Quant au méné long (*Clinostomus elongatus*), l'échantillonnage ciblé cernait des endroits de présence historique dans la rivière Irvine, un affluent de la rivière Grand. Pour le dard de sable (*Ammocrypta pellucida*), l'échantillonnage a eu lieu dans la rivière Grand même, entre les villes de Brantford et de Caledonia, en Ontario. Lors de l'échantillonnage ciblé, les techniques d'échantillonnage comprenaient la pêche à l'électricité à l'aide d'un appareil portatif et divers techniques de pêche à la senne. Trois espèces de poisson en péril ont été capturées, dont le suceur noir (*Moxostoma duquesnei*), le méné long et le méné-miroir (*Notropis photogenis*). L'échantillonnage ciblé n'a pas abouti au repérage du dard de sable dans des endroits où il y avait présence historique. On recommande davantage d'échantillonnage afin de mettre à jour le statut du dard de sable dans le bassin versant de la rivière Grand et pour surveiller des espèces de poisson en péril.

INTRODUCTION

In 2003, Fisheries and Oceans Canada (DFO) conducted targeted sampling of fish species at risk (SAR) in the Grand River Watershed. Targeted sampling refers to the non-random sampling of habitats thought to contain "target species" based on previous sampling, using gears most likely to capture "target species". Fishes that were specifically targeted include two SAR, Redside Dace (*Clinostomus elongatus*) (common and scientific names according to Nelson et al. 2004; listed in Appendix 1) and the Eastern Sand Darter (*Ammocrypta pellucida*). Targeted sampling for the Redside Dace was focused on areas of historical presence in the Irvine River, a tributary of the Grand River. Sites previously sampled by the Royal Ontario Museum were located using gps coordinates and site location descriptions. Sampling occurred primarily to the northeast of the town of Fergus, Ontario (Figure 1). Sampling for the Eastern Sand Darter took place within the Grand River proper, between the cities of Brantford and Caledonia, Ontario (Figure 2). Site descriptions can be found in Appendix 4. Sampling techniques for targeted sampling included backpack electrofishing, boat seining, bag seining and straight seining.

METHODS

ELECTROFISHING SAMPLING

Backpack electrofishing using a Smith-Root model LR-24 backpack (averaging 100 watts of direct current) was conducted during targeted sampling of both the Redside Dace and Eastern Sand Darter. Backpack electrofishing was performed from downstream to upstream, between two blocking nets (6.35 mm mesh seine nets) placed at the start and stop of the 60 m sample site. Effort was recorded in terms of seconds shocked, and ranged from 594 to 2220 seconds of shocking per site (Appendix 10). Fishes were captured in nets as they approached the surface of the water and were placed in water-filled buckets. Upon completion of the electrofishing, the sampled fishes were identified, measured and returned to the water. Voucher specimens of each species were preserved in 10% formalin for laboratory verification, and subsequent delivery to the Royal Ontario Museum (ROM) for further verification followed by cataloguing or discarding. Individual length and weight measurements were taken of all SAR caught during sampling.

SEINE NET SAMPLING

Three different seine types were used during the targeted sampling of the Grand River watershed. A boat seine, measuring 61.0 m in length, with 6.35 mm mesh, was used during the Grand River sampling, and 8.5 m bag and straight seines, with 6.35 mm mesh, were used in both the Irvine River, and Grand River sampling (Appendix 10). Seining was performed in the direction of the current (i.e., from the upstream end of the site towards the downstream end). Seining of the Irvine River was limited to a single haul per site due to the high number of snags, and damage to the nets as a result of cobble/boulder substrates and woody debris found at many of the sites. Seining of the

Irvine River followed backpack electrofishing of the site. Seining at all of the Irvine River sites covered the full width of the river and the full length of the electrofished site.

During the Grand River sampling, a boat seine was used to sample areas too deep to wade. Three individuals were needed to boat seine effectively, one holding an end of the seine onshore, one feeding the seine off the bow of the boat, and one operating the boat. Boat seining involved reversing the boat from shore and forming an arch in the downstream direction as the seine is fed out from the bow until reaching its maximum length, upon which, the boat was landed on shore. The net ends were brought together on shore, and the net was drawn in by the float and lead lines. The captured fishes were placed into water-filled buckets and subsequently identified, measured, counted and released. Voucher specimens were preserved in 10% formalin for verification in a laboratory, and subsequent delivery to the ROM for further verification followed by cataloguing or discarding. Discrete individual length and weight measurements were taken for all SAR caught.

HABITAT DATA COLLECTION

Habitat measurements at each site included: air temperature (°C), water temperature (°C), conductivity (µS/cm), Secchi depth (m), water depth (m), substrate composition (% based on the Wentworth scale), aquatic vegetation (% emergent, % floating, % submergent), distance from shore (m), stream width (m), bank slope (%), channel cover (%) and weather conditions (Appendices 6 and 7). Habitat data were collected prior to sampling.

RESULTS

BACKPACK ELECTROFISHING

A total of 18 sites were sampled by backpack electrofishing, resulting in the capture of 4822 fishes, representing 34 species (Tables 1-3, Appendix 2). The lowest catch occurred at Site 31 where a total of 13 fishes, representing 5 species, were captured. The highest catch occurred at Site 5 where a total of 557 fishes, representing 17 species, were captured.

BAG AND STRAIGHT SEINING

Data for bag seining and straight seining were combined since only two sites were sampled with a straight seine, and both seines were the same length and mesh size. A total of 17 sites were sampled (15 by bag seine), with a total of 22 seine hauls. All sites were sampled by pulling a single haul, except Sites 33 and 34 (the two sites sampled by straight seine) where three and four seine hauls were pulled, respectively. A total of 3348 fishes, representing 25 species, were captured (Tables 1-3, Appendix 3). The lowest catch occurred at Site 41 where two fishes were captured. Although no fishes were captured at Site 23, it was not considered to have the lowest catch since, following the collection of habitat data, it was determined that the site could not be seined as a

result of severe weather conditions. The highest catch occurred at Site 18 where 532 fishes, representing 15 species, were captured (Table 1, Appendix 3).

BOAT SEINING

Nine sites were sampled in the Grand River using a 60.96 m boat seine. Each site was sampled by a single haul. The nine hauls resulted in the capture of 1590 fishes, representing 23 species (Tables 1-3, Appendix 5). The lowest catch occurred at Site 39 where a total of nine fishes, representing three species, were captured. The highest catch occurred at Site 42 where 1124 fishes, representing nine species, were captured (Tables 1-2, Appendix 5).

SPECIES AT RISK

Three SAR [Black Redhorse (*Moxostoma duquesnei*), Redside Dace, and Silver Shiner (*Notropis photogenis*)] were captured during the 2003 survey. Black Redhorse, listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), was captured at three sites, with a total of four individuals captured. Three of the Black Redhorse were captured by boat seine (Sites 43 and 44), while the last was captured electrofishing at Site 32 (Table 3, Appendices 2 and 5). Habitat data for Sites 32 and 44 indicate that Black Redhorse were caught in un-vegetated areas, composed primarily of depositional sediment (Appendices 6 and 7).

A single Redside Dace, listed as Endangered by COSEWIC, was captured at Site 26 by electrofishing (Table 3, Appendix 2). It was located in an area with sediment composed of gravel (45%), silt/clay (40%) and cobble (15%). The stream width was 2.2 m, water depth was 88 cm, and it was 90% free of aquatic vegetation. Although turbidity was not recorded for the Redside Dace capture site (Site 26), all but one of the sites with Secchi depth readings in the Irvine River had a Secchi depth greater than maximum depth (Appendices 6 and 7).

A total of 22 Silver Shiners, listed as Special Concern by COSEWIC, were captured at three boat seine sites (Sites 35, 38, 40) and one was caught by straight seining at Site 33 (Table 3, Appendices 3 and 5). The sites were all located in areas where the substrate was composed of at least 50% sand, with varying degrees of cobble, silt and clay. There was no aquatic vegetation at Site 33, and sampling depth was greater than 1.2 m at all four sites.

HABITAT DATA

All of the sites sampled within the Grand River watershed in 2003 were primarily free of aquatic vegetation. The most highly vegetated sites were 27 and 28, which both had 30% submergent and 15% slender emergent vegetation. The remaining sites contained less than 45% aquatic vegetation.

Substrate varied between sites, but was primarily composed of silt/clay, cobble or gravel in Sites 1-28, and was primarily composed of sand for Sites 29-44.

Maximum sampling depth varied from 0.54 m to 1.4 m at Sites 1-34 and Site 41. All sites were sampled while wading. At boat seine sites (Sites 35-44, excluding Site 41) maximum sampli .g depth ranged from 2.5-3 m (Appendix 7).

DISCUSSION

The 2003 targeted sampling of fish SAR in the Grand River watershed resulted in the capture of 43 species of fishes, including three fish SAR. Backpack electrofishing had the highest success in terms of species captured, relative to bag, boat, and straight seining. Eight species were exclusively captured using the electrofishing unit, including: Brindled Madtom (*Noturus miurus*), Brook Trout (*Salvelinus fontinalis*), Fantail Darter (*Etheostoma flabellare*), Greater Redhorse (*Moxostoma valenciennesi*), Iowa Darter (*Etheostoma exile*), Longnose Dace (*Rhinichthys cataractae*), Pearl Dace (*Margariscus margarita*) and Redside Dace *(Clinostomus elongatus).* Boat seining captured seven unique species, including: Brown Bullhead (*Ameiurus nebulosus*), Common Carp (*Cyprinus carpio*), Largemouth Bass (*Micropterus salmoides*), Logperch (*Percina caprodes*), Northern Pike (*Esox lucius*), Silver Redhorse (*Moxostoma anisurum*), and Yellow Perch (*Perca flavescens*). Although bag and straight seining captured more species than boat seining (25 vs 23 species), no species were exclusively caught by bag or straight seine sampling.

The three fish SAR captured during the 2003 sampling include four Black Redhorse that were captured at three sites (Sites 32, 43 and 44), a single Redside Dace from Site 26, and 23 Silver Shiner from Sites 34, 35, 38 and 40. None of the sampling methods proved substantially more effective than others in locating fish SAR. Black Redhorse were captured by electrofishing and by boat seine, while Redside Dace were caught by electrofishing and Silver Shiner were caught by straight seine and boat seine. Suggesting gear effectiveness in capturing specific fish SAR with so few captures as evidence would be ill-advised. It is, however, valuable to highlight the habitat of the three fish SAR captured. The Black Redhorse was located in un-vegetated areas, composed primarily of depositional sediment, matching the description provided in the COSEWIC updated status report (Mandrak and Reid 2005). Although turbidity was not recorded from the Redside Dace capture site (Site 26), all other sites in the Irvine River had a Secchi depth greater than maximum depth, which indicates high water clarity. This, along with the mainly gravel/cobble substrate, coincides with the Redside Dace habitat preferences listed in Scott and Crossman (1998). Habitat data for the Silver Shiners indicate a preference for deeper water, with a primarily sandy substrate and free of aquatic vegetation.

Sampling conducted by the ROM in 1999 and 2000 to determine the distribution of Eastern Sand Darter in the Grand River, was successful in locating 33 Eastern Sand Darter from four sites (Appendices 8 and 9). The sites were all composed of a least 70% sandy substrate and were located in flows ranging from 0.15-0.35 m/sec. The four

sites were located downstream of the Cockshutt Bridge in Brantford, Ontario. Of the 33 Eastern Sand Darter captured, 27 were collected from Site 7, near the location Eastern Sand Darter were first discovered in the Grand River (Holm 2001). The remaining six fish were located at sites 9.5, 11.5 and 15.8 km downstream of Cockshutt Bridge. Despite having 12 sites sampled within similar areas of the Oxbow, no Eastern Sand Darters were collected in 2003 sampling.

Although the 2003 targeted sampling of fish SAR in the Grand River was successful in capturing three fish SAR, the sampling was not successful in capturing the Eastern Sand Darter. Eastern Sand Darter is historically known from two locations in the Grand River. These include downstream of Brantford, and at Caledonia, both areas targeted in this study (Figure 2). Suitable habitat, consisting of primarily coarse sand, was targeted at Sites 29-44, where sand was the primary component of substrate at all but Sites 29 and 30. Further sampling of suitable habitat (primarily areas with the highest proportion of sandy substrate) in the Grand River, between Brantford and Caledonia, is recommended to update the status of Eastern Sand Darter in the Grand River watershed.

Targeted sampling of fish SAR in the Grand River watershed in 2003 was successful in capturing three fish SAR. Although the capture of these fishes indicates their continued presence, the small number of sites and low number of fishes captured stresses the need for continued sampling in order to monitor those species captured, and to target species historically known in the watershed that were not captured.

ACKNOWLEDGMENTS

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Table 1. Summary of catch data by gear type.

Catch Data	Electrofishing	Straight and Bag Seine	Boat Seine
Total Sites Sampled	18	17	9
Total Fishes Caught	4822	3348	1590
Mean Fishes Caught/Site	267.89	196.94	176.67
Minimum Number of Fishes Caught	13	0	9
Maximum Number of Fishes Caught	557	532	1124
Mean CPUE	0.18 fishes/sec	152.18 fishes/haul	176.67 fishes/haul

Table 2. Summary of species detection by gear type.

Species Detection	Electrofishing	Bag and Straight Seine	Boat Seine
Species Richness	34	25	23
Unique Species	8	0	7
Common Species	26	25	16
Total Species Richness	**43**		

Table 3. Total number of each species captured by gear type, with total number of specimens captured in cell.

Common Name	Electrofishing	Boat Seine	Bag/Straight Seine
Black Redhorse	1	3	
Blacknose Dace	341		27
Blackside Darter	2	9	5
Bluntnose Minnow	424	468	170
Brassy Minnow	1		2
Brindled Madtom	1		
Brook Stickleback	166		45
Brook Trout	1		
Brown Bullhead		2	
Central Mudminnow	40		1
Central Stoneroller	271		68
Common Carp		1	
Common Shiner	579	8	1552
Creek Chub	420		55
Fantail Darter	148		
Fathead Minnow	39		198
Golden Redhorse		18	18
Greater Redhorse	1		
Hornyhead Chub	317		51
Iowa Darter	2		
Johnny Darter	680	35	74
Largemouth Bass		1	
Least Darter	244		18
Logperch		4	
Longnose Dace	14		
Mimic Shiner	4	918	127
Mottled Sculpin	14		1
Northern Pike		2	
Northern Redbelly Dace	61		3
Pearl Dace	1		
Pumpkinseed	2	1	
Rainbow Darter	169	1	18
Redside Dace	1		
River Chub	32		10

Table 3. Continued

Common Name	Electrofishing	Boat Seine	Bag/Straight Seine
Rock Bass	175	9	46
Rosyface Shiner	33	60	429
Silver Redhorse		4	
Silver Shiner		22	1
Smallmouth Bass	2	3	
Spotfin Shiner	1	14	43
Striped Shiner	405	4	265
Unidentified Shiner			103
White Sucker	230	1	18
Yellow Perch		2	
Total	**4822**	**1590**	**3348**

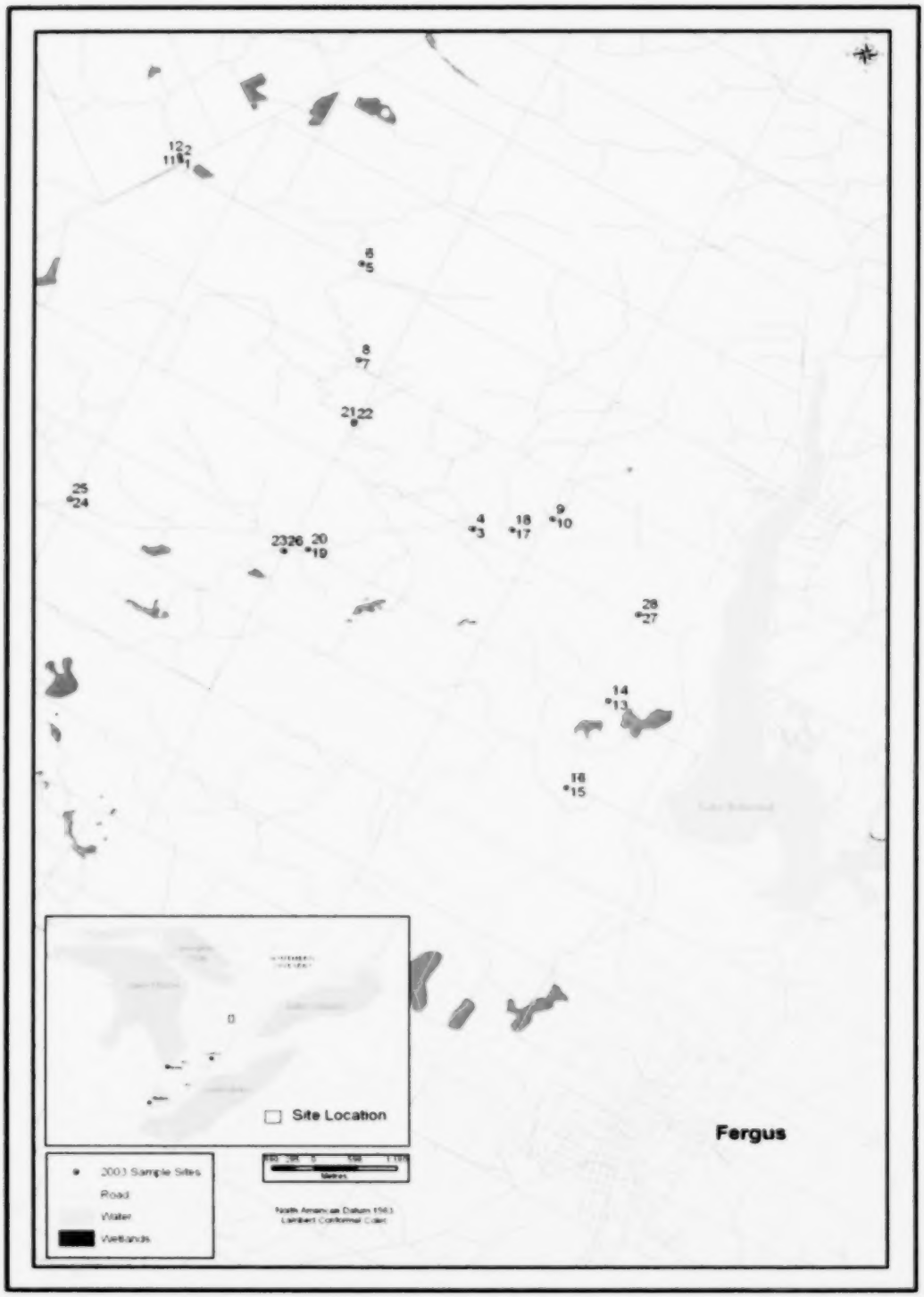

Figure 1. Sites 1-28 sampled in the Grand River watershed in 2003. See Appendix 4 for detailed site descriptions.

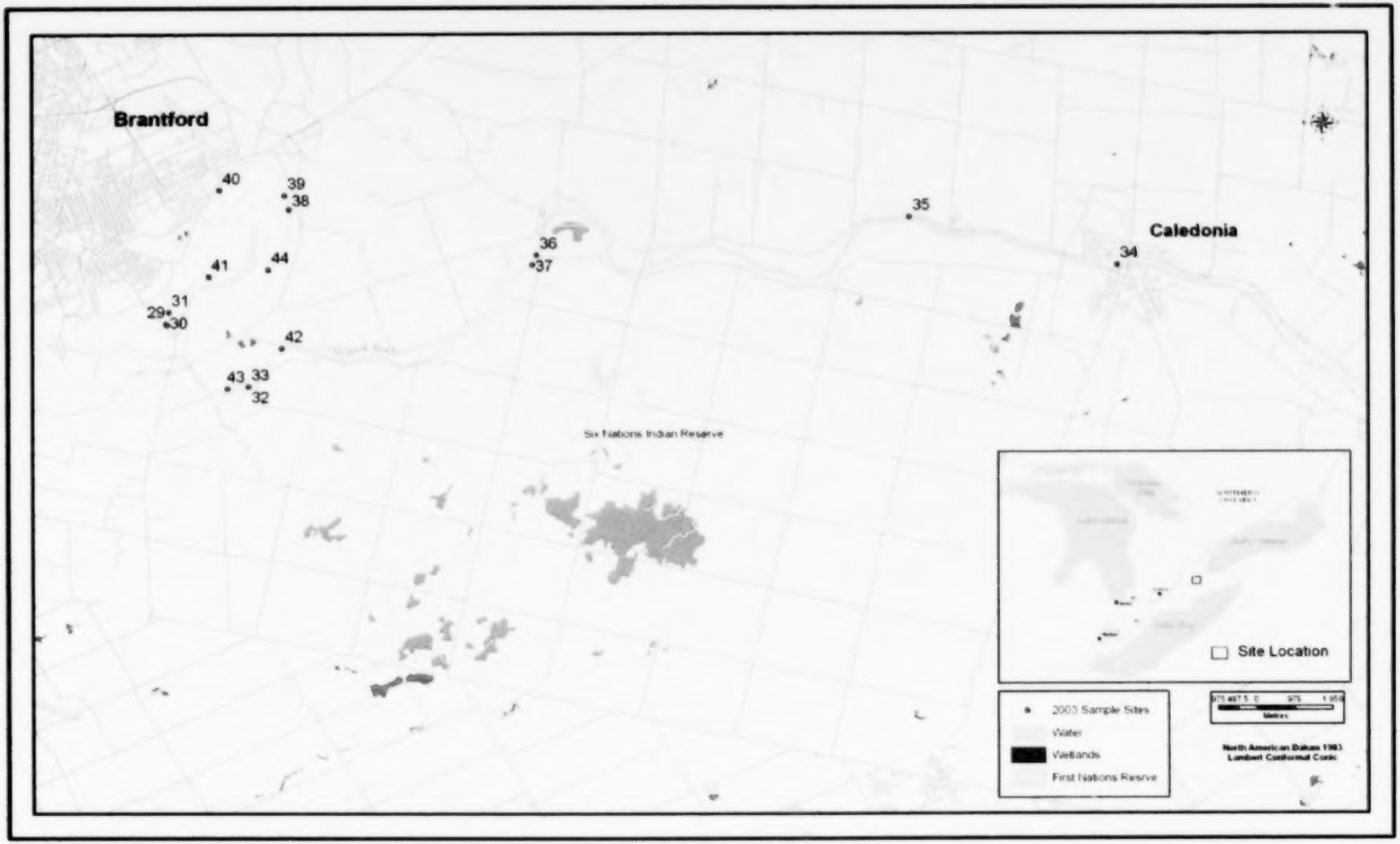

Figure 2. Sites 29-44 sampled in the Grand River watershed in 2003. ROM sites are resamples of 1999-2000 sites. See Appendix 4 for detailed site descriptions.

Appendix 1. Common and scientific names of species detected in the Grand River watershed in 1999, 2000 and 2003 (according to Nelson et al. 2004).

Common Name	Scientific Name
Black Crappie	*Pomoxis nigromaculatus*
Black Redhorse	*Moxostoma duquesnei*
Blacknose Dace	*Rhinichthys atratulus*
Blackside Darter	*Percina maculata*
Bluntnose Minnow	*Pimephales notatus*
Brassy Minnow	*Hybognathus hankinsoni*
Brindled Madtom	*Noturus miurus*
Brook Stickleback	*Culaea inconstans*
Brook Trout	*Salvelinus fontinalis*
Brown Bullhead	*Ameiurus nebulosus*
Central Mudminnow	*Umbra limi*
Central Stoneroller	*Campostoma anomalum*
Channel Catfish	*Ictalurus punctatus*
Common Carp	*Cyprinus carpio*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
Eastern Sand Darter	*Ammocrypta pellucida*
Fantail Darter	*Etheostoma flabellare*
Fathead Minnow	*Pimephales promelas*
Golden Redhorse	*Moxostoma erythrurum*
Greater Redhorse	*Moxostoma valenciennesi*
Greenside Darter	*Etheostoma blennioides*
Hornyhead Chub	*Nocomis biguttatus*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Largemouth Bass	*Micropterus salmoides*
Least Darter	*Etheostoma microperca*
Logperch	*Percina caprodes*
Longnose Dace	*Rhinichthys cataractae*
Mimic Shiner	*Notropis volucellus*
Mottled Sculpin	*Cottus bairdii*
Northern Hog Sucker	*Hypentelium nigricans*
Northern Pike	*Esox lucius*
Northern Redbelly Dace	*Phoxinus eos*
Pearl Dace	*Margariscus margarita*

Appendix 1. Continued

Common Name	Scientific Name
Pumpkinseed	*Lepomis gibbosus*
Rainbow Darter	*Etheostoma caeruleum*
Redside Dace	*Clinostomus elongatus*
River Chub	*Nocomis micropogon*
Rock Bass	*Ambloplites rupestris*
Rosyface Shiner	*Notropis rubellus*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Silver Redhorse	*Moxostoma anisurum*
Silver Shiner	*Notropis photogenis*
Smallmouth Bass	*Micropterus dolomieu*
Spotfin Shiner	*Cyprinella spiloptera*
Striped Shiner	*Luxilus chrysocephalus*
Walleye	*Sander vitreus*
White Crappie	*Pomoxis annularis*
White Sucker	*Catostomus commersonii*
Yellow Perch	*Perca flavescens*

Appendix 2. Site totals of each species captured by backpack electrofishing, with total number of specimens captured in cell. Site number corresponds to number on Figures 1 and 2, and in appendices.

Common Name	Total	1	2	3	5	7	9	11	13	15
Black Redhorse	**1**									
Blacknose Dace	**341**	36	19	34	96	36	3	4	9	7
Blackside Darter	**2**									
Bluntnose Minnow	**424**		3	47	60	65	14		12	4
Brassy Minnow	**1**		1							
Brindled Madtom	**1**									
Brook Stickleback	**166**	29	51	8	9	15	11	4		
Brook Trout	**1**									1
Central Mudminnow	**40**	10	12			2		2		1
Central Stoneroller	**271**		8	18	25	24	2		66	15
Common Shiner	**579**	82	74	62	99	40	25		18	13
Creek Chub	**420**	32	89	65	54	31	10	4	8	32
Fantail Darter	**148**			43	38	16	3		3	11
Fathead Minnow	**39**	1	3		1					
Greater Redhorse	**1**									
Hornyhead Chub	**317**		3	40	46	57	10	1	27	15
Iowa Darter	**2**						1			
Johnny Darter	**680**	40	54	37	7	65	157	5	35	19
Least Darter	**244**	23	45	57	18	22	20	2	1	
Longnose Dace	**14**						2		5	2
Mimic Shiner	**4**									
Mottled Sculpin	**14**						11			
Northern Redbelly Dace	**61**	23	22		1	3				
Pearl Dace	**1**									
Pumpkinseed	**2**									
Rainbow Darter	**169**			17	19	15	15		43	21
Redside Dace	**1**									
River Chub	**32**								9	1
Rock Bass	**175**			38	19	6	3		2	9
Rosyface Shiner	**33**			4	1	1			1	5
Smallmouth Bass	**2**									
Spotfin Shiner	**1**									
Striped Shiner	**405**	146		34	43	30	29	2	1	12
White Sucker	**230**	8	1	30	21	42	9	1	3	11
Total	**4822**	**430**	**385**	**534**	**557**	**470**	**325**	**25**	**243**	**180**

Appendix 2. Continued

Common Name	Total	17	19	21	24	26	27	29	31	32
Black Redhorse	1									1
Blacknose Dace	341	19	8	38	2	20	10			
Blackside Darter	2									2
Bluntnose Minnow	424	65	23	34	1	59	27	8		2
Brassy Minnow	1									
Brindled Madtom	1									1
Brook Stickleback	166	7	1	2	4	23	2			
Brook Trout	1									
Central Mudminnow	40		3		1	9				
Central Stoneroller	271	29	2	12		6	64			
Common Shiner	579	65	41	20		8	32			
Creek Chub	420	31	15	31	2	9	6			
Fantail Darter	148	29		2		1	2			
Fathead Minnow	39	10	16		2	6				
Greater Redhorse	1									1
Hornyhead Chub	317	32	17	31		6	32			
Iowa Darter	2		1							
Johnny Darter	680	48	50	59		60	19	14	7	4
Least Darter	244	10	12	25		8	1			
Longnose Dace	14	5								
Mimic Shiner	4							3		1
Mottled Sculpin	14					3				
Northern Redbelly Dace	61	5	3			3	1			
Pearl Dace	1				1					
Pumpkinseed	2								1	1
Rainbow Darter	169	15	5	8		2	8		1	
Redside Dace	1					1				
River Chub	32			7			15			
Rock Bass	175	21	24	34		4	3	2	3	7
Rosyface Shiner	33	11		2			5	2		1
Smallmouth Bass	2								1	1
Spotfin Shiner	1									1
Striped Shiner	405	77		21		2	8			
White Sucker	230	14	35	26		23	6			
Total	**4822**	**493**	**256**	**352**	**13**	**253**	**241**	**29**	**13**	**23**

Appendix 3. Site totals of each species captured by bag and straight seine, with total number of specimens captured in cell. Site number corresponds to number on Figures 1 and 2, and in appendices.

Common Name	Total	4	6	8	10	12	14	16	18	20
Blacknose Dace	**27**	1	2	5	1	7	2		4	2
Blackside Darter	**5**									
Bluntnose Minnow	**170**	1	5	4	12		3	16	22	33
Brassy Minnow	**2**					1				1
Brook Stickleback	**45**		18	2	14	6			2	1
Central Mudminnow	**1**					1				
Central Stoneroller	**68**		2		20	1	9	24	5	2
Common Shiner	**1552**	170	62	11	330	44	90	122	399	245
Creek Chub	**55**	2	22	3	4	3		8	7	5
Fathead Minnow	**198**		5		8	5			6	174
Golden Redhorse	**18**									
Hornyhead Chub	**51**	1	4	1	6	6	5	5	9	4
Johnny Darter	**74**		3		8	21	1	2	8	14
Least Darter	**18**	1	1	2	1	9			3	
Mimic Shiner	**127**									
Mottled Sculpin	**1**									1
Northern Redbelly Dace	**3**				1			1		1
Rainbow Darter	**18**		2	3	2		4	2	3	1
River Chub	**10**			1			8			
Rock Bass	**46**	1	25	1	11				3	2
Rosyface Shiner	**429**	38	1	4	7		51	51	52	
Silver Shiner	**1**									
Spotfin Shiner	**43**									
Striped Shiner	**265**	17	67	10	2	76	10	25	2	41
Unidentified Shiner	**103**									
White Sucker	**18**		1		1		1	2	7	4
Total	**3348**	**232**	**220**	**47**	**428**	**180**	**184**	**258**	**532**	**531**

Appendix 3. Continued

Common Name	Total	22	23	25	28	30	33	34	41
Blacknose Dace	**27**	1		2					
Blackside Darter	**5**					2	3		
Bluntnose Minnow	**170**	2			8	24	33	7	
Brassy Minnow	**2**								
Brook Stickleback	**45**			2					
Central Mudminnow	**1**								
Central Stoneroller	**68**	1			4				
Common Shiner	**1552**	78					1		
Creek Chub	**55**				1				
Fathead Minnow	**198**								
Golden Redhorse	**18**					3	14		1
Hornyhead Chub	**51**	10							
Johnny Darter	**74**				1	8	8		
Least Darter	**18**	1							
Mimic Shiner	**127**					38	30	58	1
Mottled Sculpin	**1**								
Northern Redbelly Dace	**3**								
Rainbow Darter	**18**					1			
River Chub	**10**				1				
Rock Bass	**46**	1				2			
Rosyface Shiner	**429**	12			155	8	23	27	
Silver Shiner	**1**							1	
Spotfin Shiner	**43**						8	35	
Striped Shiner	**265**				11	2	1	1	
Unidentified Shiner	**103**				103				
White Sucker	**18**					1	1		
Total	**3348**	**106**	**0**	**4**	**284**	**89**	**122**	**129**	**2**

Appendix 4. Description of sites sampled in 2003. Map # corresponds to numbers on Figures 1 and 2, and in appendices.

Map #	Field Number	Date	Locality	Latitude	Longitude
1	RDGR092903BPEF-1	29-Sep-03	Off of culvert at Hwy 109, west side of Hwy	43.85494995	-80.4059601
2	RDGR092903BPEF-2	29-Sep-03	Located at a culvert on Hwy 9, west of Hwy 9 and east/west Garafraxa town line intersection.	43.85494995	-80.4059601
3	RDGR093003-1BPEF	30-Sep-03	100 m upstream from 2nd bridge on the 5th line, north of 5th line and side road 15 intersection.	43.79595947	-80.3735199
4	RDGR093003-1SN	30-Sep-03	100 m upstream from 2nd bridge on the 5th line, north of 5th line and side road 15 intersection.	43.79595947	-80.3735199
5	RDGR100103-1BPEF	01-Oct-03	First bridge on 7th line, on north side of 20th side road	43.83546829	-80.3800812
6	RDGR100103-1SN	01-Oct-03	First bridge on 7th line, on north side of 20th side road	43.83546829	-80.3800812
7	RDGR100203-1BPEF	02-Oct-03	Located at the first bridge north of 6th line/20th side road intersection, on the 6th line	43.82239151	-80.3849335
8	RDGR100203-1SN	02-Oct-03	Located at the first bridge north of 6th line/20th side road intersection, on the 6th line	43.82239151	-80.3849335
9	RDGR100303-1BPEF	03-Oct-03	Iron bridge on side road 15, east of side road 15/5th line intersection	43.7949295	-80.3597031
10	RDGR100303-1SN	03-Oct-03	Iron bridge on side road 15, east of side road 15/5th line intersection	43.7949295	-80.3597031
11	RDGR100303-2BPEF	03-Oct-03	Hwy.109 near east/west Garafraxa town line intersection	43.85554886	-80.4059067
12	RDGR100303-2SN	03-Oct-03	Hwy.109 near east/west Garafraxa town line intersection	43.85554886	-80.4059067
13	RDGR100303-3BPEF	03-Oct-03	Bridge approx. 1.5 km north of Hwy 19 on Hwy 16.	43.7685585	-80.3587189
14	RDGR100303-3SN	03-Oct-03	Bridge approx. 1.5 km north of Hwy 19 on Hwy 16.	43.7685585	-80.3587189
15	RDGR100303-4BPEF	03-Oct-03	On 3rd line, off of Rd. 19 where bridge is out.	43.75790024	-80.3695526
16	RDGR100303-4SN	03-Oct-03	On 3rd line, off of Rd. 19 where bridge is out.	43.75790024	-80.3695526
17	RDGR101003-2BPEF	10-Oct-03	North side of the 5th line, downstream from bridge 10	43.79467011	-80.3669968
18	RDGR101003-2SN	10-Oct-03	North side of the 5th line, downstream from bridge 10	43.79467011	-80.3669968
19	RDGR101403-1BPEF	14-Oct-03	Bridge on Hwy 16, approx. 100 m south of Hwy 16/side road 20 intersection	43.79803085	-80.4019623
20	RDGR101403-1SN	14-Oct-03	Bridge on Hwy 16, approx.100 m south of Hwy 16/side road 20 intersection	43.79803085	-80.4019623
21	RDGR101403-2BPEF	14-Oct-03	Bridge on side road 20, east of 5th line/side road 20 intersection.	43.81406403	-80.3884659
22	RDGR101403-2SN	14-Oct-03	Bridge on side road 20, east of 5th line/side road 20 intersection.	43.81381989	-80.3886337

Appendix 4. Continued

Map #	Field Number	Date	Locality	Latitude	Longitude
23	RDGR101503-1SN	15-Oct-03	On side road 20 just south of Rd 16.	43.79859161	-80.4062195
24	RDGR101603-1BPEF	16-Oct-03	Midway between Hwy 16 and 3rd line.	43.81195831	-80.4398727
25	RDGR101603-1SN	16-Oct-03	Midway between Hwy 16 and 3rd line.	43.81195831	-80.4398727
26	RDGR102303-1BPEF	23-Oct-03	Bridge on side road 20, just off of Hwy 16.	43.79850006	-80.4060135
27	RDGR102303-2BPEF	23-Oct-03	Bridge on 5th line off Hwy 19 (heading west on 5th line)	43.77947998	-80.349823
28	RDGR102303-2SN	23-Oct-03	Bridge on 5th line off Hwy 19 (heading west on 5th line)	43.77947998	-80.349823
29	ESDGR102103-	21-Oct-03	25 m downstream of Cockshutt Bridge on Hwy 4.	43.11027145	-80.2444992
30	ESDGR102103-1SN	21-Oct-03	25 m downstream of Cockshutt Bridge on Hwy 4.	43.11003113	-80.2442932
31	ESDGR102103-	21-Oct-03	600 m downstream of Cockshutt Bridge on Hwy 4.	43.11288071	-80.2428131
32	ESDGR102203-	22-Oct-03	Located at the tributary crossing River Rd just before	43.09112167	-80.2248764
33	ESDGR102203-1SN	22-Oct-03	Located at the tributary crossing River Rd just before	43.09112167	-80.2248764
34	ESDGR102203-2SN	22-Oct-03	Site is ~0.5 km down Forfar St. off of the Island.	43.07255173	-79.9559708
35	ESDGR102803-1BS	28-Oct-03	N/A	43.09516144	-80.0142212
36	ESDGR102803-2BS	28-Oct-03	N/A	43.10639954	-80.1284485
37	ESDGR102803-3BS	28-Oct-03	N/A	43.10438156	-80.1304474
38	ESDGR102903-1BS	29-Oct-03	N/A	43.13042831	-80.198761
39	ESDGR102903-2BS	29-Oct-03	N/A	43.13401031	-80.1989822
40	ESDGR102903-3BS	29-Oct-03	N/A	43.13871002	-80.2179718
41	ESDGR102903-4SN	29-Oct-03	N/A	43.11896133	-80.2280579
42	ESDGR103003-1BS	30-Oct-03	Grand River, downstream of Newport Bridge	43.09830856	-80.2117615
43	ESDGR103003-2BS	30-Oct-03	Located under hydro lines	43.09178162	-80.2312622
44	ESDGR103003-3BS	30-Oct-03	1.5 km upstream of Newport Bridge	43.11745071	-80.2096176

Appendix 5. Site totals of each species captured by boat seine, with total number of specimens captured in cell. Site number corresponds to number on Figures 1 and 2, and in appendices.

Common Name	Total	35	36	37	38	39	40	42	43	44
Black Redhorse	**3**								1	2
Blackside Darter	**9**		1				1			7
Bluntnose Minnow	**468**		5	2		4	2	401	32	22
Brown Bullhead	**2**			1						1
Common Carp	**1**									1
Common Shiner	**8**						5	3		
Golden Redhorse	**18**				6			1		11
Johnny Darter	**35**		4	3	3	1		13	1	10
Largemouth Bass	**1**									1
Logperch	**4**							1	3	
Mimic Shiner	**918**	6	42	24	33	4	1	700	52	56
Northern Pike	**2**				1			1		
Pumpkinseed	**1**			1						
Rainbow Darter	**1**						1			
Rock Bass	**9**			1				1	3	4
Rosyface Shiner	**60**	1	1	3	18		21			16
Silver Redhorse	**4**			1	1				2	
Silver Shiner	**22**	12			6		4			
Smallmouth Bass	**3**				1		1			1
Spotfin Shiner	**14**	3		5	1				5	
Striped Shiner	**4**						1	3		
White Sucker	**1**			1						
Yellow Perch	**2**				2					
Total	**1590**	**22**	**53**	**42**	**72**	**9**	**37**	**1124**	**99**	**132**

Appendix 6. Summary of substrate by site sampled in 2003. Map # corresponds to numbers in Figures 1 and 2, and in appendices.

Map #	Air Temp. (°C)	Water Temp. (°C)	Secchi Depth (m)	Substrate Type 1	Substrate Type 1 (%)	Substrate Type 2	Substrate Type 2 (%)	Substrate Type 3	Substrate Type 3 (%)	Substrate Type 4	Substrate Type 4 (%)
1	9	10.4	0.54	silt/clay	100		0		0		0
2	9	10.4		silt/clay	100		0		0		0
3	6.5	10.4		gravel	45	pebble	20	boulder	10	silt/sand	25
4	7	8.6		gravel	45	pebble	20	boulder	10	silt/sand	25
5	4	8.2	.62	cobble	60	gravel	15	boulder	15	silt	10
6	7	8.2		cobble	60	gravel	15	boulder	15	silt	10
7	2	7.2	max	boulder	10	cobble	60	gravel	25	silt/sand	5
8	2	7.2	1.25	boulder	10	cobble	60	gravel	25	silt/sand	5
9	4	6.4		boulder	15	cobble	45	gravel	30	silt/clay	10
10	4	6.4		boulder	15	cobble	45	gravel	30	silt/clay	10
11	4	6.2		silt/clay	90	boulder	5	cobble	5		0
12	4	6.2		silt/clay	90	boulder	5	cobble	5		0
13	10	7.4		boulder	15	cobble	70	gravel	15		0
14	10	7.4		boulder	15	cobble	70	gravel	15		0
15	10.2	8.5		gravel	10	cobble	60	silt/clay	20	boulder	10
16	10.2	8.5		gravel	10	cobble	60	silt/clay	20	boulder	10
17	5	8.1		gravel	50	cobble	20	muck	25	boulder	5
18	5	8.1		gravel	50	cobble	20	muck	25	boulder	5
19	12	8.8		silt/clay	70	cobble	25	boulder	5		0
20	12	8.8		silt/clay	70	cobble	25	boulder	5		0
21	14	11.1	0.85	silt/clay	30	cobble	70		0		0
22	14	11.1	0.85	silt/clay	30	cobble	70		0		0
23	7	9.3	0.15	gravel	0	cobble	0	silt/clay	0		0
24	12.4	9.3		silt/clay	60	gravel	40		0		0
25	12.4	9.3		silt/clay	60	gravel	40		0		0
26	-3.5	4		clay/silt	40	gravel	45	cobble	15		0
27	3.5	5.3	1.2	silt	5	gravel	25	cobble	65	boulder	5
28	3.5	5.3		silt	5	gravel	25	cobble	65	boulder	5
29	12	11.2		gravel	65	sand	15	clay/silt	20		0
30	12	11.2		gravel	65	sand	15	clay/silt	20		0
31	12.2	11.3		silt/clay	40	sand	60		0		0
32	6	9.6		sand	70	silt/clay	20	cobble	10		0

Appendix 6. Continued

Map #	Air Temp. (°C)	Water Temp. (°C)	Secchi Depth (m)	Substrate Type 1	Substrate Type 1 (%)	Substrate Type 2	Substrate Type 2 (%)	Substrate Type 3	Substrate Type 3 (%)	Substrate Type 4	Substrate Type 4 (%)
33	6	9.6		sand	70	silt/clay	20	cobble	10		0
34	5.8	10.2		sand	60	gravel	30	cobble	10		0
35	11	8.8		sand	50	cobble	10	silt	20	clay	20
36	0	0		sand	60	silt	20	clay	20		0
37	10.5	8.2		sand	60	cobble	40		0		0
38	10.5	8.3		sand	55	cobble	30	clay/silt	15		0
39	11	8.8		sand	60	silt	20	clay	20		0
40	11	8.7		sand	50	cobble	10	clay	20	silt	20
41	11	8.8		sand	80	silt	10	clay	10		0
42	0	0		sand	60	silt	20	clay	20		0
43	0	0			0		0		0		0
44	0	0		sand	50	clay/silt	50		0		0

Appendix 7. Summary of aquatic vegetation by site sampled in 2003. Map # corresponds to numbers on Figure 1 and 2, and in appendices.

Map #	Aquatic Vegetation Type 1	Type 1 (%)	Aquatic Vegetation Type 2	Type 2 (%)	Aquatic Vegetation Type 3	Type 3 (%)	Stream Width (m)	Max. Depth (m)	Sample Depth (m)	Cond. (µS/cm)
1	submergent	35	none	65		0	3.65	0.54	0.54	665
2	submergent	35	none	65		0	3.65	0.54	0.54	665
3	submergent	20	emergent	15	none	65	2	1.03	1.03	697
4	submergent	20	emergent	15	none	65	2	1.03	1.03	669
5	submergent	15	slender emergent	25	none	60	2	0.62	0.62	690
6	submergent	15	slender emergent	25	none	60	2	0.62	0.62	690
7	submergent	15	slender emergent	15	floating	5	2.5	1.25	1.25	665
8	submergent	15	slender emergent	15	floating	5	2.5	1.25	1.25	665
9	slender emergent	10	none	90		0	4	1.4	1.4	654
10	slender emergent	10	none	90		0	4	1.4	1.4	654
11	submergent	25	slender emergent	10	none	65	3.65	0.54	0.54	688
12	submergent	25	slender emergent	10	none	65	3.65	0.54	0.54	688
13	slender emergent	5	none	95		0	5	1.1	1.1	618
14	slender emergent	5	none	95		0	5	1.1	1.1	618
15	slender emergent	5	none	95		0	4			609
16	slender emergent	5	none	95		0	4			609
17	submergent	15	emergent	5	none	80	2	1.35	0.8	
18	submergent	15	emergent	5	none	80	2	1.35	1.35	
19	slender emergent	10	floating	10	none	80	3	1.03	1.03	664
20	slender emergent	10	floating	10	none	80	3	1.03	1.03	664
21	slender emergent	15	submergent	15	none	70	10	0.85	0.85	665
22	slender emergent	15	submergent	15	none	70	10	0.85	0.85	665
23	none	100		0		0	2	>1.5		
24	submergent	5	none	95		0	1.5	0.83	0.83	569
25	submergent	5	none	95		0	1.5	0.83	0.83	569
26	submergent	10	none	90		0	2.2	0.88	0.88	715
27	submergent	30	slender emergent	15	none	55	5.5	1.2	1.2	700
28	submergent	30	slender emergent	15	none	55	5.5	1.2	1.2	700
29	slender emergent	2	submergent	5	none	93	45		1.15	826
30	slender emergent	2	submergent	5	none	93	45		1.3	826
31	none	100		0		0	35		0.9	831

Appendix 7. Continued.

Map #	Aquatic Vegetation Type 1	Type 1 (%)	Aquatic Vegetation Type 2	Type 2 (%)	Aquatic Vegetation Type 3	Type 3 (%)	Stream Width (m)	Max. Depth (m)	Sample Depth (m)	Cond. (µS/cm)
32	none	100		0		0	3	1.2	1.2	727
33	none	100		0		0	3	1.2	1.2	727
34		0		0		0	135	>1.1m	1.1	816
35		0		0		0	70		2.5	
36	submergent	10	none	90		0				
37		0		0		0	70		2.5	
38		0		0		0	70		2.5	
39		0		0		0	70		2.5	
40		0		0		0	50		2.5	
41	none	100		0		0	55		1.2	
42	none	100		0		0	60	2	3	
43		0		0		0	50		2.5	
44	none	100		0		0	50		2.5	

Appendix 8. Fishes caught by site, during Royal Ontario Museum sampling of the Grand River watershed in 1999 and 2000.

Common Name	1	2	3	4	5	6	7	8	9
Black Crappie									
Black Redhorse									
Blackside Darter			2					1	
Bluntnose Minnow		54	1	36			1		25
Brassy Minnow		3							
Brindled Madtom									
Channel Catfish							1		
Common Shiner		247	1			20	1		1
Creek Chub			2						
Eastern Sand Darter							27		
Golden Redhorse									
Greenside Darter			1		7	1	2		
Hornyhead Chub			10						
Johnny Darter	1	5	1	10		1	1		2
Logperch									
Longnose Dace			1						
Mimic Shiner		35	1		3		1		
Minnow Spp.									
Northern Hog Sucker			1	4	14	1	1		
Northern Pike			1						
Pumpkinseed									
Rainbow Darter	1		1		3	2		2	
Redhorse Spp.									
River Chub	2		6						
Rock Bass			1				1		
Rosyface Shiner		105	1		184	10	3		
Shiner Spp.		3							
Shorthead Redhorse						2			
Silver Redhorse						1			
Silver Shiner	17		3	8	33	14	13		
Smallmouth Bass			1	19	1	2	1		
Spotfin Shiner				20	2	37	2		1
Striped Shiner	1	76	24	26	1	54	119		
Walleye									
White Crappie									
White Sucker	1		1	1					
Yellow Perch									
Total	**23**	**528**	**60**	**124**	**248**	**145**	**174**	**3**	**29**

Appendix 8. Continued

Common Name	10	11	12	13	14	15	16	17
Black Crappie		1			1			
Black Redhorse			1					
Blackside Darter		2						
Bluntnose Minnow	7		4	5	125	72	6	10
Brassy Minnow								
Brindled Madtom		2	1					
Channel Catfish								
Common Shiner								4
Creek Chub								
Eastern Sand Darter	1	1	4					
Golden Redhorse			1					
Greenside Darter	1							3
Hornyhead Chub								
Johnny Darter	6	1	2	50	15	1	1	
Logperch	1							
Longnose Dace								
Mimic Shiner	16	3	2		7	240		45
Minnow Spp.	4		2					
Northern Hog Sucker		3						
Northern Pike								
Pumpkinseed				2		1	1	
Rainbow Darter								1
Redhorse Spp.		1						
River Chub								
Rock Bass								
Rosyface Shiner	2		21			8		66
Shiner Spp.								
Shorthead Redhorse	1							1
Silver Redhorse	1							
Silver Shiner	2							
Smallmouth Bass								
Spotfin Shiner	3	1			33	60		93
Striped Shiner	4							2
Walleye		1						
White Crappie							7	
White Sucker								
Yellow Perch	1							
Total	**50**	**16**	**38**	**57**	**181**	**382**	**15**	**225**

Appendix 9. Description of sites sampled in the Grand River watershed by the Royal Ontario Museum in 1999 and 2000.

Site	Waterbody	Locality	Latitude	Longitude	Easting	Northing	Datum
1	Nith River	West of Ayr at C.P. railway bridge	431712	-802747	543544	4792596	NAD 1927
2	Nith River	Ayr, 50 m upstream from Piper St. bridge. At junction of Cedar Creek and Nith River	431707	-802708	544433	4792442	NAD 1927
3	Nith River	Ayr south, 0.5 km. Downstream from Piper St. bridge	431650	-802702	544596	4792118	NAD 1927
4	Grand River	West Brantford: at downstream end of channel about 1 km. Downstream (southwest) of Wilke's Dam	430838	-801815	556570	4776840	NAD 1927
5	Grand River	West Brantford: between islands, 1 1/2 km downstream of Wilke's Dam	430823	-801818	556500	4776375	NAD 1927
6	Grand River	West Brantford /at/above the storm sewer outflow at the top of Kerby Island, east bank	430818	-801717	557885	4776225	NAD 1927
7	Grand River	The Oxbow, 2.5 km downstream of Cockshutt Bridge. Southeast Brantford, The Oxbow, approximately 275 m downstream (east) of sewage treatment plant outflow	430709	-801340	562800	4774100	NAD 1927
8	Grand River	East Brantford, just west of Cainsville, on west bend of Oxbow; at mouth of Mohawk Creek.	430819	-801305	563600	4776300	NAD 1927
9	Grand River	East Brantford, approx. 1.5 km south of Cainsville; east bend of The Oxbow	430802	-801156	565150	4775793	NAD 1927
10	Grand River	East Brantford, approx. 2.0 km south of Cainsville; east bend of The Oxbow	430749	-801155	565171	4775396	NAD 1927
11	Grand River	Grand River, The Oxbow, approx. middle of southern arm	430702	-801234	564310	4773949	NAD 1927
12	Grand River	Grand River, 1.3 km downstream of Newport bridge, south of Brantford	430530	-801355	562552	4771081	NAD 1927
13	Grand River	North-east corner of Six Nations Indian Reserve	430553	-801234	564128	4771810	NAD 1927
14	Grand River	North side of Six Nations Indian Reserve	430616	-800750	570758	4772558	NAD 1927
15	Grand River	North side of Six Nations Indian Reserve	430622	-800742	570918	4772784	NAD 1927
16	Grand River	Approximately 4.1 km upstream from Caledonia Dam, along Hwy. #54	430543	-800051	580228	4771639	NAD 1927
17	Grand River	Caledonia, below dam on north side of large island	430426	-795731	584779	4769358	NAD 1927

Appendix 10. Summary of effort by site sampled in 2003. Map # corresponds to numbers on Figures 1 and 2, and in appendices.

Map #	Method	Effort	Effort Units	Settings	Description of Method
1	BackpackEF	2220	Seconds	155 Volts, 0.68 Amps, 102 Watts	Smith Root LR 24 Backpack Unit
2	BackpackEF	2220	Seconds	155 Volts, 0.68 Amps, 102 Watts	Smith Root LR 24 Backpack Unit
3	BackpackEF	2055	Seconds	182 Volts, 0.54 Amps, 92 Watts	Smith Root LR 24 Backpack Unit
4	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
5	BackpackEF	1736	Seconds	183 Volts, 0.51 Amps, 98 Watts	Smith Root LR 24 Backpack Unit
6	Seine, Bag	1	Hauls		Bag seine, 1/4" mesh, 8.5 m
7	BackpackEF	1477	Seconds	184 Volts, 0.48 Amps, 88 Watts	Smith Root LR 24 Backpack Unit
8	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
9	BackpackEF	1410	Seconds	184 Volts, 0.52 Amps, 98 Watts	Smith Root LR 24 Backpack Unit
10	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
11	BackpackEF	1284	Seconds	179 Volts, 0.5 Amps, 100 Watts	Smith Root LR 24 Backpack Unit
12	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
13	BackpackEF	1255	Seconds	174 Volts, 0.54 Amps, 103 Watts	Smith Root LR 24 Backpack Unit
14	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
15	BackpackEF	1513	Seconds	184 Volts, 0.36 Amps, 60 Watts	Smith Root LR 24 Backpack Unit
16	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
17	BackpackEF	1860	Seconds	194 Volts, 0.42 Amps, 184 Watts	Smith Root LR 24 Backpack Unit
18	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
19	BackpackEF	1839	Seconds	141 Volts, 0.71 Amps, 105 Watts	Smith Root LR 24 Backpack Unit
20	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
21	BackpackEF	1147	Seconds	177 Volts, 0.6 Amps, 105 Watts	Smith Root LR 24 Backpack Unit
22	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
23	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
24	BackpackEF	692	Seconds	184 Volts, 0.53 Amps, 99 Watts	Smith Root LR 24 Backpack Unit
25	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
26	BackpackEF	1719	Seconds	159 Volts, 0.62 Amps, 98 Watts	Smith Root LR 24 Backpack Unit

Appendix 10. Continued

Map #	Method	Effort	Effort Units	Settings	Description of Method
27	BackpackEF	1857	Seconds	157 Volts, 0.60 Amps, 100 Watts	Smith Root LR 24 Backpack Unit
28	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
29	BackpackEF	620	Seconds	172 Volts, 0.6 Amps, 98 Watts	Smith Root LR 24 Backpack Unit
30	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5 m
31	BackpackEF	594	Seconds	134 Volts, 0.75 Amps, 100 Watts	Smith Root LR 24 Backpack Unit
32	BackpackEF	680	Seconds	148 Volts, 0.68 Amps, 102 Watts	Smith Root LR 24 Backpack Unit
33	Seine, Straight	3	Hauls		Straight seine (mini) - 1/4" mesh
34	Seine, Straight	4	Hauls		Straight seine (mini) - 1/4" mesh
35	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
36	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
37	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
38	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
39	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
40	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
41	Seine, Bag	1	Hauls		Bag seine; 1/4" mesh; length, 8.5m
42	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
43	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh
44	Seine, Boat	1	Hauls		Boat seine, 200', 1/4" mesh